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THE DEFENSIVE ATTITUDE OF THE MANTID *IDOLUM DIABOLICUM* SAUSS. (ORTHOPTERA)

By Eric Burtt, B.Sc., F.R.E.S., with notes by Prof. G. D. Hale Carpenter.

(The following notes came in a letter to me from Mr. Eric Burtt, at Tindi Research Laboratory, via Lohumbo, Tanganyika Territory, dated 5 December, 1942.—G.D.H.C.)

" There is a cultivated plot of land about a quarter of a mile away, where we grow food for the animals. It was down there between 18–20 Nov. that I found this handsome Mantid in numbers and witnessed the remarkable sight it presents in its attitude of defence. There are one or two old 'Pride of Barbadoes' bushes there and the Mantids were resting upside down on the twigs well inside the bush. The first one I saw, and disturbed, was a male. It walked upside down and I noticed that it opened and shut its broad front femora and slid one femur over the other in a slow forward and backward motion. This displayed startlingly bright colours. Then I found several specimens and witnessed the full degree of display. Normally the insect is upside down on a twig : suddenly it stretches out its two fore legs to their full extent to form an arch over its head, giving a vivid and striking display of colour. In this gesture the head and thorax are bent back at about 60° to the line of the abdomen : this attitude may be held for half a minute or more. At the same time a loud stridulation or clicking is produced by the hind femora, which bear one or two big spines, being rasped against the tegmina. The abdomen is moved up and down in time with this movement of the legs. The ' toute ensemble ' affords one of the most striking displays I have ever seen in any insect; the only thing comparable being the behaviour of the big ' Stick Insect ' which I sent you on a former occasion." [See 1942, *Proc. R. ent. Soc. Lond.* (A) **17 : 75**.]

Mr. Burtt's observations are almost the same as some which I made during the East African campaign of the last war (see 1921, *Trans. ent. Soc. Lond.* **1921**: 1–105), and it is most interesting to receive this independent confirmation. The sketch in colours sent by Mr. Burtt shows the appearance of which I gave a poor drawing (*loc. cit.* : 12) except that the tibiae and tarsi are in the proper position, parallel with each other, which I could not reproduce in an old, dried and relaxed, specimen. I did not record the movement of the abdomen mentioned by Mr. Burtt.

NOTES ON *BRACHYMERIA* SP. (CHALCIDIDAE), A PUPAL PARASITE OF *CACTOBLASTIS CACTORUM* BERG.

By J. Sneyd Taylor, M.A., D.I.C., F.R.E.S.

The genus *Brachymeria* occurs throughout the greater part of the world, with the exception, apparently, of the more northern sections of Europe, Asia and America. Several species have been recorded as pupal, and a few also as larval parasites of a wide range of Lepidoptera. Among the lepidopterous hosts are species belonging to the following families:—Tinaeidae; Tortricidae; Pyralidae; Psychidae; Drepanidae; Lasiocampidae; Nymphalidae; Lycaenidae; Pieridae; Papilionidae; Hesperiidae; Sphingidae; Geometridae; Bombycidae; Syntomidae; Noctuidae and Lymantriidae. In the Coleoptera, a few species of Chrysomelidae have been recorded as hosts, and in the Diptera, species of both Sarcophagidae and Tachinidae. Among the parasitic Hymenoptera, *Brachymeria* has been obtained from Ichneumonidae and Braconidae, but in this case, as in that of the Diptera referred to above, *Brachymeria* was a hyperparasite of Lepidoptera.

Included among the more important lepidopterous pests which have been parasitised by species of *Brachymeria* are the codling moth (*Carpocapsa pomonella* L.); the cabbage moth (*Plutella maculipennis* Curt.), and the pink bollworm (*Platyedra gossypiella* Saund.). The common silkworm (*Bombyx mori* L.) has also been recorded as a host, while it is interesting to note that a species of *Brachymeria*, viz. *B. cactoblastidis*, has been described by E. E. Blanchard from *Cactoblastis bucyrus* Dyar in the Argentine. In his bulletin entitled "The Biological Campaign against Prickly-Pear" (Brisbane, 1940), A. P. Dodd mentions that *Brachymeria ruskini* was obtained from the pupa of *Cactoblastis cactorum* in Australia, but in negligible numbers. In South Africa, apparently the only species of *Brachymeria* hitherto recorded is *B. polyctor*, obtained from wattle bagworm (*Acanthopsyche junodi* Heyl.).

The following notes deal with the occurrence of *Brachymeria* sp. in the Karroo only, while the life-history studies were undertaken at the Prickly Pear Laboratory, Graaff-Reinet.

History and Incidence of *Brachymeria* sp. in the Karroo.

The presence of *Brachymeria* was first noted in 1939, when 0·02% of *Cactoblastis* pupae of the summer generation, obtained from the Graaff-Reinet commonage, were found to have been parasitised by this Chalcid. The latter was at first thought to be a hyperparasite affecting a species of *Pimpla* (Ichneumonidae), which for some time has been known to be a pupal parasite of *Cactoblastis*. This assumption, however, later proved to be wrong.

In order to determine the extent of insect parasitism of *Cactoblastis*, cocoons of both summer and winter generations have been regularly collected since the summer of 1939 up to the present. The cocoons are collected at three localities, viz. Graaff-Reinet commonage; Platdrift, Aberdeen; and Swanepoelskraal, Jansenville. In the summer of 1939, cocoons were collected at Graaff-Reinet only, but from the winter of 1939, collections were made from the Aberdeen locality; while from summer, 1941, they were carried out in Jansenville also.

Owing to the almost complete absence of cocoons at Platdrift, Aberdeen, in the summer of 1942, the collection had to be made at another farm some five miles away. Apart from this, the collections have always been carried out at the same places in each locality. Up to the summer of 1941, four thousand cocoons were collected from each locality, but since then the number collected has been two thousand.

The figures for the percentage of total parasitism (*i.e.* total number of pupae killed by the parasite, including those in which immature stages of the latter were found) by *Brachymeria* for the years 1939–1942 are given in Table 1, as follows :—

TABLE 1.

Year	Locality					
	Graaff-Reinet		Aberdeen		Jansenville	
	Summer	Winter	Summer	Winter	Summer	Winter
1939 . .	0·02	0·02	—	0·1	—	—
1940 . .	0·37	2·7	0·07	1·1	—	—
1941 . .	15·8	12·8	17·8	36	8·3	15·9
1942 . .	31·5	7·9	8·3	10·3	20·5	18·4

From Table 1 it will be seen that, in the case of the Graaff-Reinet pupae, there was a slight but gradual increase in the percentage of parasitism by *Brachymeria* from the winter generation, 1939, when it was 0·02%, to 2·7% in winter, 1940. In the following summer (1941) generation, the figure jumped to 15·8%, but dropped to 12·8% in the succeeding winter. In 1942 there was a substantial increase to 31·5% in the summer generation, but the figure fell to 7·9% in the winter. The increases and fluctuations of parasitism by *Brachymeria* in the pupae from the other two localities are somewhat similar, but in the winter, 1941, generation, in the case of the Aberdeen material, it rose to 36%, the highest percentage hitherto, or since, recorded. The figures for parasitism by *Brachymeria* are much higher than those for any other parasite of *Cactoblastis* so far noted in the Karroo. It is not anticipated, however, that they will increase much further.

Biology and Bionomics.

Indigenous Hosts.

Up to the present, no indigenous host for the species of *Brachymeria* under review has been found. Under laboratory conditions, the adult punctured the cocoons of *Terastia meticulosalis* Guén. (PYRALIDAE), the larva of which bores in the shoots of *Erythrina caffra* (kaffirboom), but without results, possibly because the cocoons in question were too advanced in age. Negative results were also obtained with the cocoons of *Braura truncata* Walker (NOTODONTIDAE), the larva of which feeds upon the foliage of *Acacia karroo*, the cocoons probably being too tough for the parasite to puncture. Similar results were obtained with the pupae of *Papilio demodocus* Esp. Dr. A. J. T. Janse has suggested the following five species of Lepidoptera as possible hosts :—*Veldticola megista*; *Crocidomera euprepia*; *Mussidia melanoneura*; *Metoecia carnifex*; and *Euzo-*

phera villora. Up to the present, however, the writer has not found any of these species locally, and, in common with the vast majority of our lepidopterous fauna, little or nothing is known of their habits, immature stages and food-plants. As has been mentioned previously, *Brachymeria polyctor* has been recorded from wattle bagworm, but there appears to be nothing else known of these Chalcids and their hosts in South Africa. The writer has hitherto failed to find any Acacia bagworms locally.

The Adult.

Life-history studies on *Brachymeria* were undertaken at Graaff-Reinet, commencing in October, 1941. It was soon established, beyond doubt, that this Chalcid is a pupal parasite of *Cactoblastis*. This was accomplished by exposing to it fresh cocoons, cage-reared, known not to have been subject to attack by the parasite previously. Some weeks later adult parasites emerged from the cocoons thus exposed.

It was at first attempted to rear *Brachymeria* in 4″ × 1″ vials, but the results were negative, and no attempt to puncture the cocoons was apparently made by the parasites. The latter were then transferred to 1-lb. fruit jars, and in these they showed no hesitation in tackling the cocoons. A certain amount of space would therefore seem to be necessary for the adult parasite to function normally.

The adults feed readily, and can subsist upon raisins which are slightly moistened with water daily. In warm weather they are very active, but on cool days remain quiescent. They mate, and commence tackling cocoons, immediately after emergence, if the temperature conditions are suitable. The female parasite tears, with its mandibles, a relatively large hole in the host cocoon, usually in the side, but sometimes at either end. It then enters by the hole, to oviposit in the pupa, and often remains within for some hours. No injury is noticeable to the pupa with a hand-lens (× 10). Oviposition may take place in the same host pupa more than once, but in this case the result is generally negative, the host pupa, together with any immature parasites contained therein, dessicating. As a general rule, only one adult parasite emerges from one host pupa, but very occasionally two may do so. In this case, however, the second parasite to emerge is considerably under the normal size. Although a cocoon may be punctured any time after its formation right up to the day immediately preceding moth emergence, the period during which the pupa can be successfully parasitised is obviously considerably shorter than this. *Cactoblastis* pupae which are sufficiently advanced in development are not affected by the parasite, and it would appear that the latter, under laboratory conditions at any rate, is unable to discriminate as to the suitability of hosts so far as age is concerned. In the case of 132 pupae which were successfully parasitised (*i.e.* from which adult parasites emerged, or in which dead immature parasites were found) in the period October to December, 1942, all were stung between the third and thirty-sixth day after the formation of the cocoon. The cocoons punctured on the eleventh day after their formation gave the best results, as far as the number of adult parasites reared was concerned, while those punctured on the twelfth day were a close second. The average number of days, after the formation of the cocoon, on which the 132 hosts were punctured was 14·1. During the summer generation (January to March), when the pupal period of *Cactoblastis* is considerably shorter than in the winter generation, the average duration at Graaff-Reinet being 22 days in the former, and 61 days in the latter,

the period during which the Chalcid can successfully parasitise the pupa is necessarily somewhat shorter, and no results have been obtained with pupae stung later than the twenty-second day after the formation of the cocoon. The average number of days after the formation of the cocoons on which pupae of the summer generation were successfully parasitised was 12·2. Although cocoons may be punctured as early as the day after their formation, it seems that parasitisation cannot take place until pupation has been completed.

The adult parasite, on reaching maturity, makes a hole, usually at or near the anterior end of the host pupa, and thus emerges into the cocoon, from which it escapes by the hole made by its parent. The duration of the adult period for 15 pairs in the summer generation varied, in the case of the male, from 2 to 93 days, the average being 40·9 days. In the case of the female, the period varied from 10 to 56 days, with an average of 27·7 days. In the winter generation the period for 20 males varied from 5 to 49 days, with an average of 27·1 days, while that for 22 females varied from 8 to 52 days, the average being 27 days. In the case of 14 males which emerged in the autumn, and which never had access to females, the duration of life varied from 37 to 80 days, with an average of 51·3 days. Virgin females, which readily puncture cocoons and oviposit, survived up to 71 days.

It seems evident, from the length of the adult period, that *Brachymeria* can carry over from one generation of *Cactoblastis* to the next, especially as the two generations of the latter now overlap to a considerable extent.

The number of cocoons punctured by one female varies, the maximum recorded being 24, but the number of resulting progeny is less than the number of cocoons punctured. From the 24 punctured cocoons, referred to above, 16 adult parasites were obtained, and this was the largest number of offspring recorded for one female. Fifteen pairs, during the period January to June, 1942, produced 133 progeny, including those which died in immature stages, an average of 8·8 per female. In the period October to December, 1942, 27 paired females produced a total of 156 progeny, including those which died in immature stages, the average number per female being 5·8.

Proportion of Sexes.

The proportion of sexes among laboratory-reared *Brachymeria* varies, the male sex predominating. In October–December, 1941, of 76 adult parasites reared, 39, or 51·3%, were males. In January–June, 1942, out of a total of 124 adults reared, 73, or 59%, were males, while in October–December, 1942, the number of males was 65, or 52%, out of a total of 125 reared. In the case of virgin females, the progeny were all males.

Immature Stages.

The duration of the egg stage of the Chalcid is not known, while that of the egg and larval stages combined is approximately 14 days in summer. The duration of the entire developmental period (egg to adult) varies considerably with the time of year, the female, on an average, taking slightly longer to develop than the male. In October–December, 1941, males emerged after periods varying from 30 to 45 days, the average for 16 being 35·3 days, while females were obtained in from 23 to 41 days, the average for 17 being 35·8 days. During January–April, 1942, the developmental period for 37 males varied from 19 to 35 days, with an average of 24·8 days, while that for females

occupied from 20 to 38 days, the average for 44 being 25·3 days. In March–July, 1942, the developmental period was considerably prolonged, occupying up to 80 days, with an average of 51·3 days for 14 males. During October–December, 1942, the average figures obtained were very similar to those for the same period of the previous year. For 52 males the duration of the developmental period varied from 25 to 43 days, with an average of 35 days, while for 38 females it varied from 29 to 43 days, the average being 35·5 days.

Influence of the situation of the host cocoon upon the percentage of parasitism by Brachymeria.

In order to determine the influence of the situation of the host cocoon upon the percentage of parasitism by *Brachymeria*, one thousand cocoons were collected from each of six different situations, as follows :—well exposed; well buried under debris, etc.; between prickly pear joints; in decayed stumps; under stones; and in loose soil around karroo bushes. This was undertaken for the winter generation, 1941, and the summer generation, 1942. The results are given in Table 2 :—

TABLE 2.

Situation of cocoons	% Parasitism	
	Winter, 1941	Summer, 1942
Well exposed	6·1	17·6
Well buried	2·5	10
Between joints	6·5	28·1
In decayed stumps . . .	7·5	13·5
Under stones	19·5	10·2
In loose soil	3	11·4

From Table 2 it will be seen that the cocoons which occur in more exposed situations are more liable to parasitism by *Brachymeria* than are those better protected under some form of cover, such as those found well buried under debris, or in loose soil around karroo bushes. It will also be noticed that the percentage of parasitism among cocoons found under stones was much higher for the spring than for the summer generation. This was probably due to the fact that, in the summer generation, a much higher percentage of these cocoons died from causes other than insect parasites. The fierce summer heat beating upon the stones would possibly account for this higher rate of mortality, and, but for this, the percentage of parasitism by *Brachymeria* among these cocoons might have been considerably higher in the summer generation.

In addition to the above investigations, cage-reared cocoons, known not to have been subject to attack by *Brachymeria*, were buried under half-an-inch of loose soil, and were not removed for examination until after moth emergence had ceased. This experiment was also carried out for both winter and summer generations. In the case of the former, the cocoons were disturbed by ants, many being carried off, and others left exposed, while at least 4·5% were parasitised by *Brachymeria*. The summer cocoons were rendered secure from disturbance by ants, and none was found to have been parasitised. Perhaps it should be mentioned that in this experiment the winter generation cocoons

were placed in an exposed situation, while those of the summer generation were kept in permanent shade, under a tree.

Summary.

(1) *Brachymeria* spp. have frequently been recorded as parasites of Lepidoptera throughout the greater part of the world.

(2) A species of *Brachymeria* is the most important insect parasite of *Cactoblastis cactorum* Berg. in the Karroo.

(3) Details of the occurrence of this Chalcid in the Karroo, its biology and bionomics, are given and discussed.

Acknowledgments.

The writer is indebted to Dr. F. W. Pettey, Senior Entomologist, Division of Entomology, and Officer-in-Charge, Biological Control of Prickly Pear, for permission to publish this paper, and for helpful criticism and advice; to Dr. A. J. T. Janse for suggestions as to possible hosts of *Brachymeria*; to Mr. B. J. Vosloo, Division of Entomology, for much assistance with the investigational work involved; and to the Imperial Institute of Entomology for the determination of the Chalcid as a species of *Brachymeria*.

LIFE HISTORY DATA FOR *PTINUS TECTUS* BOIE. (COLEOPTERA, PTINIDAE) AT 70% RELATIVE HUMIDITY AT 21° C. AND 25° C.

By R. W. Howe, B.Sc., A.R.C.S., F.R.E.S.

(*Pest Infestation Laboratory, Slough.*)

Ewer and Ewer (1942) have given an account of the effect of temperature and relative humidity on the duration of the life cycle of *Ptinus tectus* Boie. Neither they nor Hickin (1942), however, could investigate thoroughly the duration of the larval instars. None of the earlier work on this species was done with both temperature and relative humidity controlled. Therefore it is considered worth while to publish data obtained with this species during the course of other work from October 1942 to January 1943.

About fifty adults for egg laying were obtained from an insectary culture, provided with wet cotton wool and kept overnight at 21° C. These were then placed in an oviposition tin standing on a Petri dish containing fishmeal which had been passed through a 100-mesh sieve and conditioned in a constant temperature room at 25° C. and 70% R.H. for a fortnight prior to use. The oviposition tin with the insects was kept at 25° C., the temperature of the subsequent observations, and eggs were sieved off on two consecutive days, a 60-mesh sieve being used. Fresh adults were obtained for the repeat experiment at 21° C. which was started about a fortnight later.

About fifty eggs were kept each day and placed in a Petri dish kept in a desiccator at the appropriate temperature. The relative humidity in the desiccator was controlled at 70% using a potassium hydroxide solution of specific gravity 1·23 at 15° C. This was renewed every six weeks.

The eggs were examined daily at about the same time until they hatched. Only 2% failed to do so at each temperature. The larvae were placed singly with a little unsieved fishmeal in glass specimen tubes, 2 in. by ½ in., closed by a bored cork covered with muslin. These were kept in desiccators as above. Daily examinations were continued without removing the larvae from the tubes except on the few occasions when this was necessary to find a larva. The dates of hatching, moulting and pupating were noted, and all cast skins were removed when discovered. Excess of food was always present.

TABLE 1.

25° C. and 70% R.H.

Instar	Based on 53 insects completing larval development			Based on all eggs hatched		
	No.	Mean and standard deviation in days	Coeff. variation, %	No.	Mean and standard deviation in days	Coeff. variation, %
Egg	53	7·9 ± 1·19	14·98	72	8·0 ± 1·25	15·60
Larva I	53	9·1 ± 1·31	14·38	61	9·2 ± 1·11	12·03
Larva II	53	11·4 ± 1·06	9·27	57	11·4 ± 1·09	9·58
Larva extra	8	9·5 ± 2·21	23·26			
Larva III	53	23·2 ± 2·91	12·55			
Larva total	53	45·2 ± 4·33	9·59			
Pupa	51	9·9 ± 0·60	6·08			
Total: Egg to adult in cocoon	51	63·04 ± 4·64	7·36			

Time spent in cocoon is not noted.

TABLE 2.

21° C. and 70% R.H.

Instar	Based on 99 insects completing larval development			Based on all eggs hatched		
	No.	Mean and standard deviation in days	Coeff. variation, %	No.	Mean and standard deviation in days	Coeff. variation, %
Egg	99	8·6 ± 0·73	8·49	108	8·6 ± 0·73	8·46
Larva I	99	12·1 ± 2·50	20·67	100	12·1 ± 2·51	20·74
Larva II	99	16·2 ± 1·97	12·14			
Larva extra	5	16·4 ± 3·90	23·84			
Larva III	99	30·7 ± 3·17	10·33			
Larva Total	99	59·9 ± 6·01	10·03			
Pupa	93	15·9 ± 0·77	4·83			
Total: Egg to adult in cocoon	93	84·48 ± 6·05	7·16			
Pre-emergence period *	84	9·5 ± 1·27	13·34			
Total: Egg to adult emerged from cocoon	84	93·69 ± 5·94	6·34			

* The remainder made poor cocoons in which they did not remain after becoming adult.

Generally three larval moults were observed, but occasionally an extra moult was interpolated, apparently before the final moult. During the final instar the larva spins a cocoon in which it pupates. The time at which this was formed was not noted as the degree of perfection of construction varied and some larvae did not succeed in making a complete cocoon. Pupation and the emergence of the adult from the pupa occurred within this case, but as the case was usually formed against the glass, these changes could be observed in nearly every insect.

All these observations show that with fishmeal as food development is slower and more variable than Ewer and Ewer found with a "synthetic" and optimal diet. Hickin, however, working at 20° C. and 70% R.H. using as food pure potato starch supplemented with yeast powder or wheat germ and also with pure casein plus yeast powder, obtained approximately the same average duration of life cycle as obtained here at 21° C. and 70% R.H. All the other foods he used gave longer life cycles. Using larvae fed on plain flour at a relative humidity of 50%, and keeping them after pupation at 20° C. and 70% R.H. he obtained a shorter pupal period (13·8 days) and a similar pre-emergence period (9·5 days) compared with the results given here.

The optimum temperature for speed of development for this species is about 22·5° C. At this temperature and 75% R.H. using wholemeal flour and yeast mixture for food, Ewer and Ewer obtained for the three larval instars average durations of 7·2 $\pm$ 0·15, 8·6 $\pm$ 0·12, and 20·71 $\pm$ 0·61 days, respectively.

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Ewer, D. W., and Ewer, R. F., 1942, The biology and behaviour of *Ptinus tectus* Boie. (Coleoptera, Ptinidae), a pest of stored products. III. The effect of temperature and humidity on oviposition, feeding and duration of life cycle. *J. exp. Biol.* **18** : 290–305, 4 figs., 4 tables, 22 refs.

Hickin, N. E., 1942, The food and water requirements of *Ptinus tectus* Boie. (Coleopt., Ptinidae). *Proc. R. ent. Soc. Lond.* (A) **17** : 99–108, 10 tables, 10 refs.

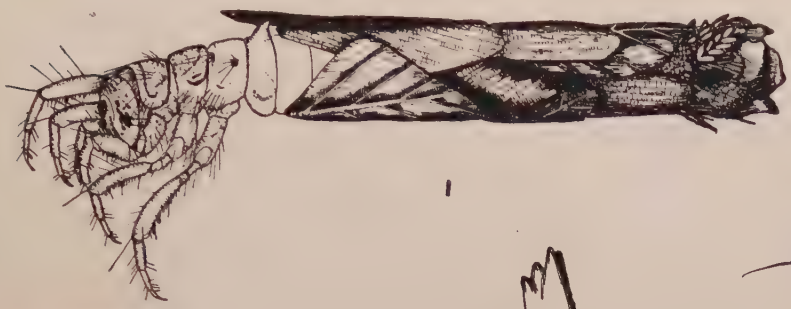
LARVAE OF THE BRITISH TRICHOPTERA. 12

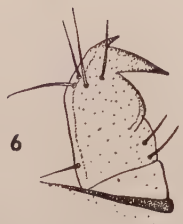
By N. E. Hickin, Ph.D., F.R.E.S.

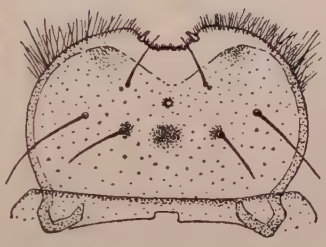
Limnophilus lunatus Curtis (Limnophilidae).

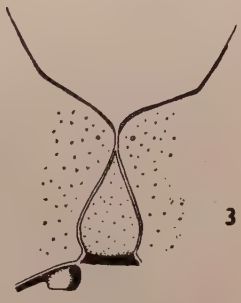
Fully-fed larvae of this species were found to be abundant in a small stream at Temple Balsall, Warwickshire, on 30.vi.42. This fast-running stream is barely a yard wide for much of its length and seldom a foot in depth. There is a profuse marginal growth of such aquatic plants as *Nasturtium officinale*, *Veronica becca-bunga* etc., etc., and the larvae were confined to the submerged stems of these plants. It is apparently in a stream similar to this that *Limnophilus lunatus* larvae have caused extensive damage to watercress beds, necessitating insecticidal action by the owners. The larvae, however, are not confined to swiftly running water as they were found to be quite common in a pool in Broadmoor Wood, Rubery, Worcestershire, and are reported by Mosely as being " found in most waters." Larvae from both localities were reared to the adult stage and the species determination confirmed.

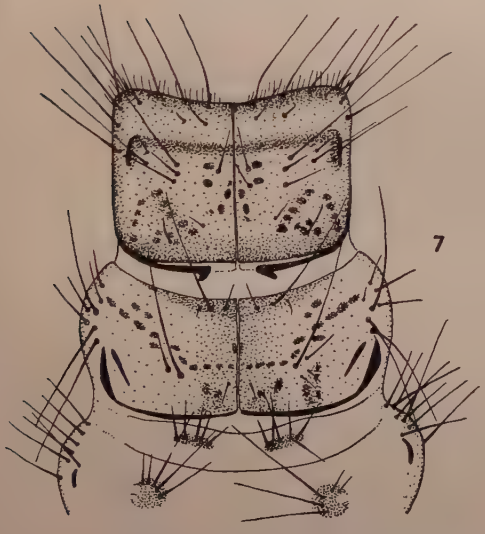
Case (fig. 1): of whole leaves, cut leaves and vegetable debris cemented together, the material usually laid with its long axis longitudinal and overlapping. Where the whole leaves of hawthorn had been used the cases could have been confused with those of *Glyphotaelius pellucidus* Retz. Length 20–23 mm., width 4 mm. Sometimes the case is constructed of broken snail shells, as in the Hampshire chalk streams and, in addition, sand grains are occasionally used. *Larva*: eruciform, cylindrical, head orthocentrous. Pronotum and mesonotum sclerotised, metanotum with sclerotised patches. Length 17 mm., width 3 mm. *Head* (fig. 2): elliptical, broader aborally. Surface covered with minute spines and with numerous long hairs projecting orally. Yellowish-brown with dark chestnut-brown to black markings. Central club-shaped dark mark in the clypeus extending transversely at the oral end. Genae darker in colour towards the clypeus, but leaving three light-coloured patches. One median light patch situated in the aboral vertex of the clypeus and a pair of light bands running obliquely from the narrow part of the clypeus to the outer extremity of the oral end. An extensive pattern of dark marks situated both in the genae and the clypeus. At the aboral end of the latter, the so-called " clypeus-mark " consists of 10–11 dark marks arranged in a kite shape. At the narrow neck of the clypeus is a large dark mark, whilst at the oral end there are four dark marks, the pair nearer to the oral margin closer together than those farther from this margin. Antennae small but visible from the front of the head. Chaetotaxy as in figure. Genae contiguous behind head for a short distance above the gular sclerite (fig. 3). Aborally, the margins of the genae are chestnut coloured near the median line, turning to black as they extend laterally. *Mouth-parts*: Labrum (fig. 4). Centre of anterior margin deeply notched. Anterior margin hairy. A dark mark between middle bristles in the transverse row of bristles. A pair of dark marks near the anterior margin, one on each side of the notch. Mandible (fig. 5) black, four-toothed. Two bristles at base. Maxillary (fig. 6) palp four-segmented. Numerous blunt, yellow spines at base of palp and mala. Mala obtuse with cluster of sense organs at tip, some hair-like. Four sharp spines on mala inwardly directed. Labium hairy. Labial palp with base protuberant from labium and with cluster of slender sense organs at tip. On mentum near base of mala a group of special hairs with











FIGS. 1–9.—1, Case. 2, head. 3, gular sclerite. 4, labrum. 5, mandibles. 6, maxilla and labium. 7, thorax. 8, leg (prothoracic). 9, anal claw.

broad bases, projecting inwards. *Thorax* (fig. 7): pronotum sclerotised, just as wide as the head, light chestnut-brown in colour with greyish-brown darker markings. Anterior margin dark greyish-brown edged with long bristles and short hairs. Anterior third of pronotum devoid of spots but marked off by a dark narrow transverse band which turns posteriorly at its lateral extremities. Posterior margin black except in centre. Prosternal horn present. Mesonotum wider than pronotum, light yellowish-brown in colour with dark anterior margin and black posterior margin. Just within the upturned tip of the black posterior marginal line there is an oblique black mark. In the centre of the mesonotum is a transverse row of dark brown spots which also slope anteriorly towards its extremities. Metanotum with sclerotised patches, anterior pair smaller and closer together than posterior pair. Small black lunate mark in each pleural region. *Legs*: prothoracic legs (fig. 8) shortest with well-marked row of dark brown spots on anterior face of tibia. *Abdomen*: cylindrical, white in colour. Median dorsal and lateral protuberances present. Lateral line and sclerotised pustules present. Abdominal gills present but lateral presegmental gills absent from second segment, whilst the notal presegmental gill groups in the second to fourth segments usually consists of only two filaments. The presegmental ventral gill groups always consist of two filaments. (Note. In general, it is thought that the absence or presence of gills is probably a bad discriminating feature among species where the range of habitat is such as to show wide divergences in oxygenation of the water. But as Ulmer uses this for his key to the limnophilid species it is included here.) Posterior margin of anal sclerite with four long and five short bristles on anterior margin. One short bristle occurs between the central pair of large bristles and a pair of short bristles occur on each side between the outer bristles; in addition, five short bristles occur as a single transverse row at about the centre of the sclerite. Anal claw (fig. 9) with auxiliary claw and with a few short bristles at its base.

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LARVAE OF THE BRITISH TRICHOPTERA. 13

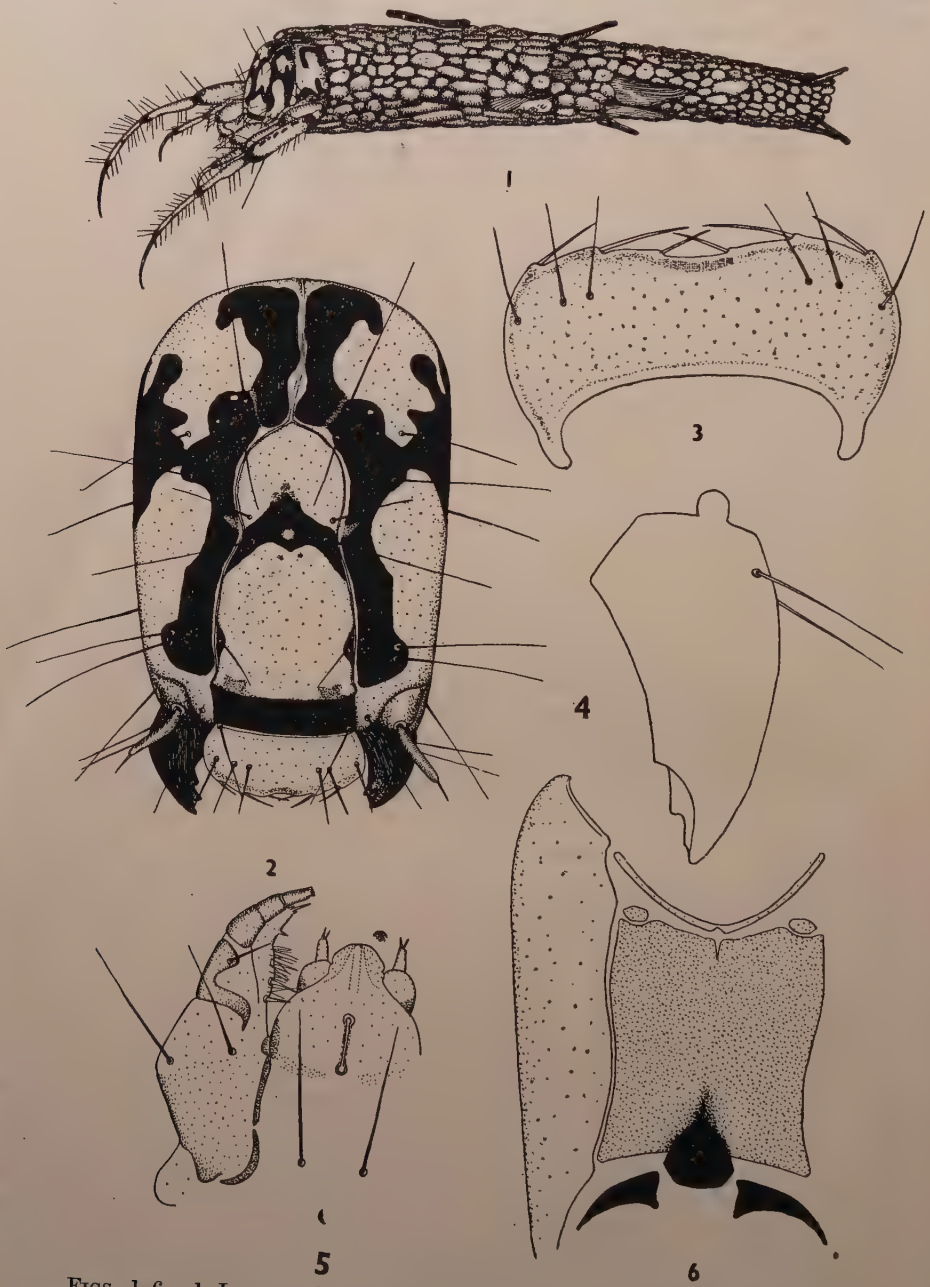
By N. E. Hickin, Ph.D., F.R.E.S.

Mystacides nigra L. (Leptoceridae).

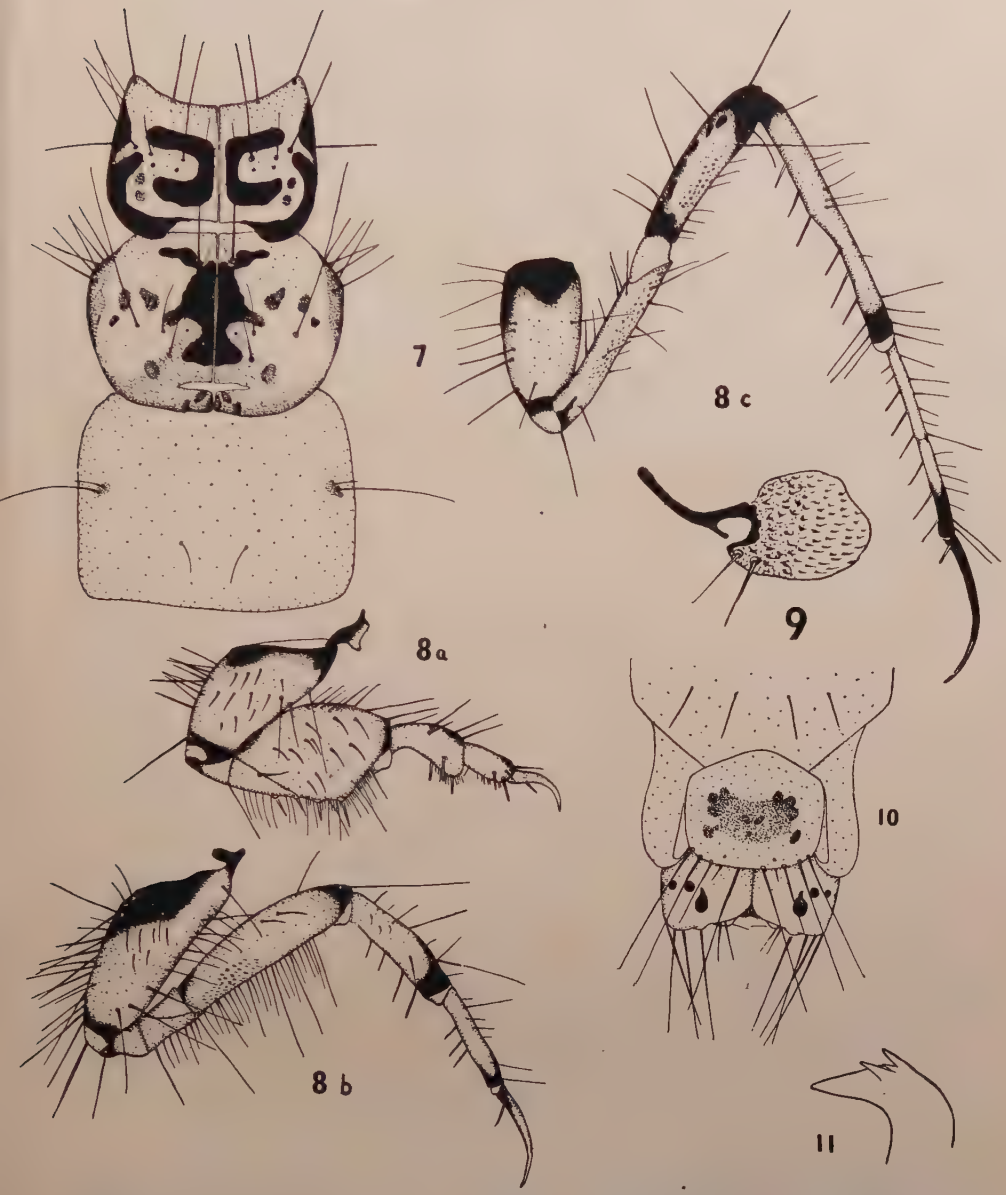
Larvae of this species are found in rivers, streams, lakes and ponds. The specimens from which this description is taken were collected from a small fast-running stream at Temple Balsall, Warwickshire. The larvae were present in considerable numbers on the lower parts of stems of marginal plants. They were also collected from Wray, Lake Windermere, where they were found crawling over algae-covered stones at the lake edge; and the case was constructed of small flakes of stone.

Case (fig. 1): cylindrical, tapered and very slightly curved. It is constructed of sand grains, cemented together with secretion, to which are attached small portions of hard vegetable debris usually dark in colour. It is also reported that the case is occasionally constructed entirely of vegetable debris. Length up to 15 mm., width 2·0–2·5 mm. *Larva*: eruciform, head procentrous. Pro- and mesonota sclerotised, metanotum with a pair of very small sclerotised patches. Abdomen tapering slightly from second segment. Length 12 mm., width 1·5 mm. *Head* (fig. 2): long, light golden yellow strongly marked in dark-brown or black. Clypeus narrow, only very slightly widened at oral end. Antennae two-segmented, proximal segment bulbous, distal segment long, terminating in a single stout bristle. A pair of irregularly shaped black bands stretch from the frontal region of the genae, on each side of the suture, almost as far as the oral region of the clypeus, an angled connecting transverse black band stretching across the clypeus at the central constriction. A light mark in the centre of this band may be present. A pair of irregularly shaped black blotches connect with the black band near the aboral end of the clypeus and stretch round to the cervical region. The oral margin of the clypeus bounded by a wide black transverse band. Chaetotaxy as figure. *Mouth-parts*: labrum (fig. 3) with anterior margin sclerotised and notched at insertion of the three pairs of spines. On ventral surface, hairs usually not very numerous but tend to occur in two separate tracts on each side. Mandibles (fig. 4): asymmetrical, four-toothed, the left mandible being somewhat broader at the base than the right. Each bears two long bristles. Maxilla (fig. 5) has maxillary palp four-segmented but basal segment is not sclerotised on the inner face and proximal part of sclerotised part is produced inwardly. Maxillary lobe almost as long as palp. Labial palps have bulbous base dark in colour at the proximal end. *Gular sclerite* (fig. 6): quadrangular with two small distinct elliptical sclerites and a single narrow transverse bow-shaped sclerite at the proximal end. *Thorax* (fig. 7): pronotum sclerotised, golden yellow heavily marked in black. Posterior margin with wide black border except for small central portion. This border turns anteriorly along the pleural region and may contain several light-coloured areas. A large X-shaped black mark in the centre of the pronotum divided longitudinally by the suture. Prosternal horn absent. Mesonotum sclerotised, little wider than pronotum, golden yellow, heavily marked with black. Posterior margin and pleural region greyish-brown. Central black mark divided by longitudinal suture and has three wing-like projections on each side. The position of other smaller dark marks is shown in fig. 7. Metanotum not sclerotised except for a pair of very small patches, from each of which arise two bristles. *Legs* (fig. 8, a, b and c): prothoracic short, femur broad, tibia with lower margin dilated at distal extremity, each tipped with black on its upper surface. Mesothoracic leg longer, femur, tibia and tarsal segment tipped with black. Femur with region of small spines occurring singly, and in groups of two, three and four. Metathoracic leg very long; segments tipped with black. Tarsal claw long. Trochanter and femur with regions of small grouped spines. Distal

half of tibia attenuated. *Abdomen*: white in colour. First abdominal segment narrow. Lateral protuberances on first abdominal segment with sclerite and patch of posteriorly projecting spines (fig. 9). Dorsal protuberance present. Lateral line not prominent. Lateral row of about 18 small chestnut-coloured pustules on 8th segment in line with lateral line. Anal sclerite irregularly shaped, darker in colour at lateral extremities.



Figs. 1–6.—1, Larva and case. 2, head. 3, labrum. 4, right mandible. 5, maxilla and labium (from below). 6, gular sclerite.



FIGS. 7–11.—7, Thorax. 8, legs: a. prothoracic; b. mesothoracic; c. metathoracic. 9, lateral sclerite on first abdominal segment. 10, anal segments. 11, anal claw.

Transverse row of dark marks on proximal lobes of anal claws. Anal claws (fig. 11) very small, furnished with three auxiliary claws, one being minute. Gills occur singly in segments two to five.

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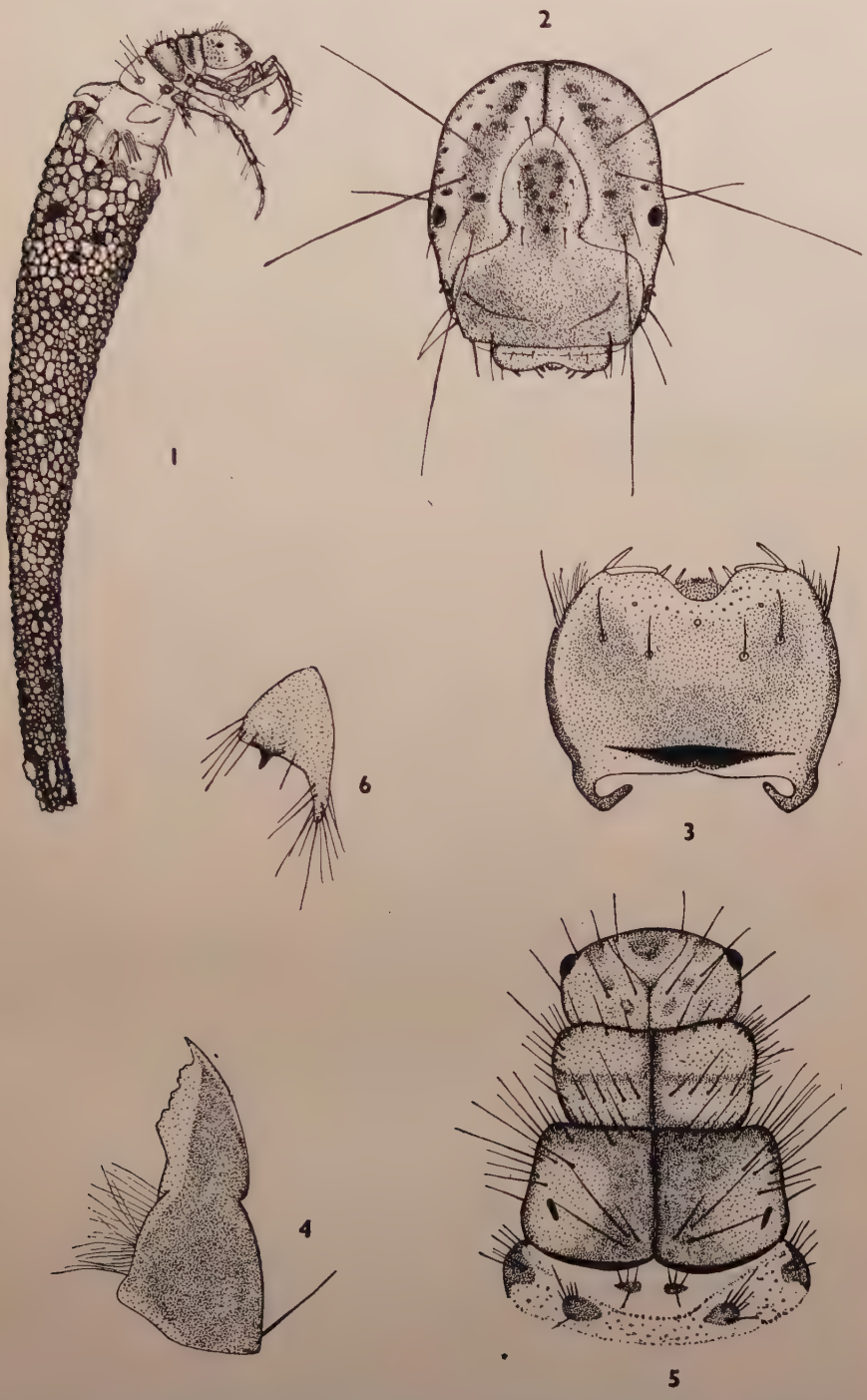
LARVAE OF THE BRITISH TRICHOPTERA. 14

By N. E. Hickin, Ph.D., F.R.E.S.

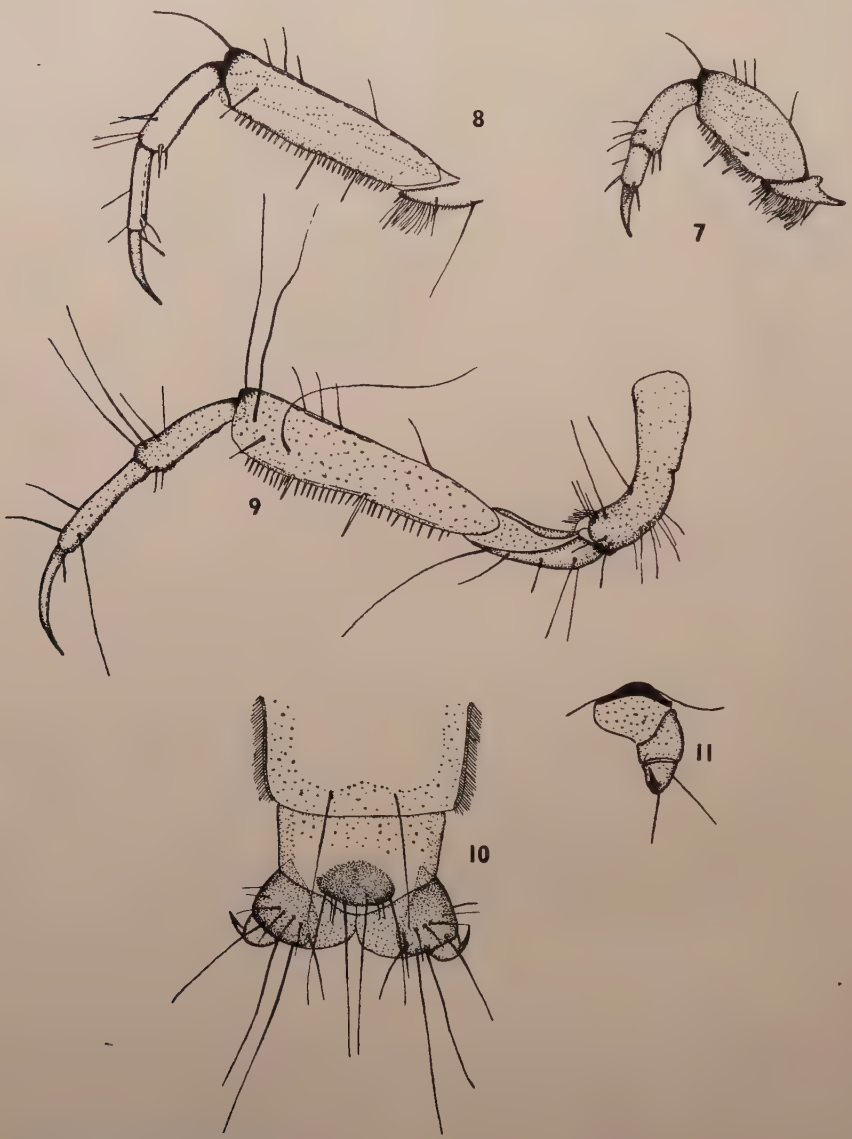
Limnophilus vittatus Fabricius (Limnophilidae).

A number of caddis larvae collected from the canal at King's Heath, Birmingham, were confirmed as belonging to this species on examination of the adult stage to which they were reared. The water is still, with some marginal vegetation.

The case is made of sand grains cemented together by means of secretion. It is curved and is much larger at the head end than at the anal. Anterior opening somewhat oblique. Length 12–20 mm., width 2·2 mm. *Larva* (fig. 1): small for a species of this genus. Eruciform with head orthocentrous. Abdominal gills present. Pro- and mesonota sclerotised, metanotum partially sclerotised. Length 12 mm., width 2 mm. *Head* (fig. 2): round. Yellowish-brown. Finely sculptured all over. Small convexities in region of eyes. Large dark mark at aboral end of clypeus in which are situated ten darker spots in the shape of a kite. Several rows of dark spots running along genae, the row nearest the clypeus on each side is joined together by a dark band. Three pairs of bristles arising from genae are very long (almost as long as length of head). Three pairs of short bristles are situate at aboral end and two pairs of longer bristles arise from the oral end of the clypeus. *Mouth-parts* (fig. 3): labrum deeply concave on anterior margin. A small spinulose protuberance in centre of concavity. Three pairs of spines set transversely across the dorsal surface of the labrum, while the ventral surface is almost completely covered with long hairs. Lateral edges of labrum heavily sclerotised and continuous with peg-like projection bent inwards and forwards. Very heavily sclerotised black bow-shaped region stretches transversely near posterior margin. Several pairs of spines along anterior margin; very often some are broken. Mandibles (fig. 4) asymmetrical. Fringe of fine hairs along basal half of inside edge, a bristle at base of outer edge. Well-defined ridge about midway along outer edge. *Maxillae*: with 4-segmented palp. *Labium*: with 1-segmented palp. *Thorax* (fig. 5): pro- and mesonota sclerotised, metanotum (fig. 6) partially sclerotised; prosternal spine present. Prothorax just as wide as the head, light chestnut-brown, darker along anterior and posterior margin with a dark band transversely in the middle of the segment and darker along the median line longitudinally. Longitudinal median suture present. Mesothorax wider than prothorax, dark chestnut-brown, shading lighter towards the sides. Posterior and lateral margin black, anterior margin very dark chestnut-brown, small black oblique mark on each side laterally. Mesothorax with two pairs of dorsal and two pairs of lateral sclerites all provided with spines. The inner anterior pair of dorsal sclerites is smaller. Of the two pairs of lateral sclerites, the coxal sclerites have a dark spine on the outer margin. Chaetotaxy of thorax as figure. *Legs* (figs. 7–9): prothoracic leg short and broad. Spines and bristles along ventral margin of femur and coxa. Mesothoracic leg twice as long as prothoracic. Tarsal claw long. Spines and bristles along ventral margin of femur and trochanter. Metathoracic leg half as long again as mesothoracic. Tarsal claw very long. Spines and bristles along ventral margin of femur only. A small spine is present at the base of each tarsal claw. *Abdomen* (figs. 10–11): greyish-white, tapering distally, gills present. Lateral fringe of hairs. Well-developed dorsal and lateral protuberances on first abdominal segment. Anal claspers have large basal sclerites each with two transverse rows of spines (one marginal). Last abdominal segment has sclerotised patch with a row of spines along the posterior margin, four of which are long with two pairs of small spines in between the outer pairs of long spines.



Figs. 1–6.—1, Lateral view of larva and case. 2, head. 3, labrum. 4, mandible. 5, head and thoracic segments. 6, coxal sclerite, metanotum.



Figs. 7–11.—7, Prothoracic leg. 8, mesothoracic leg. 9, metathoracic leg. 10, anal segments. 11, lateral view of anal claw.

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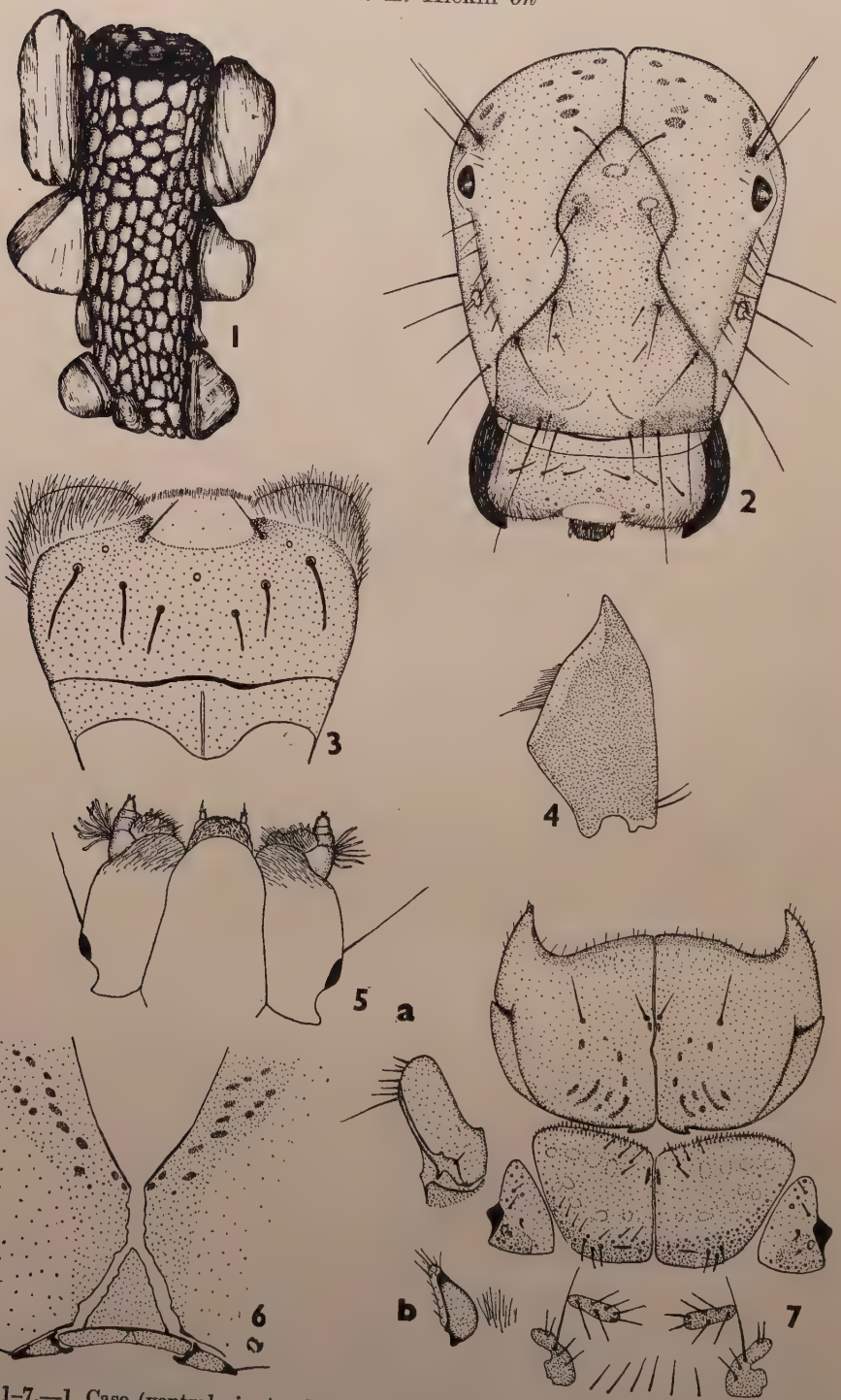
LARVAE OF THE BRITISH TRICHOPTERA. 15

By N. E. Hickin, Ph.D., F.R.E.S.

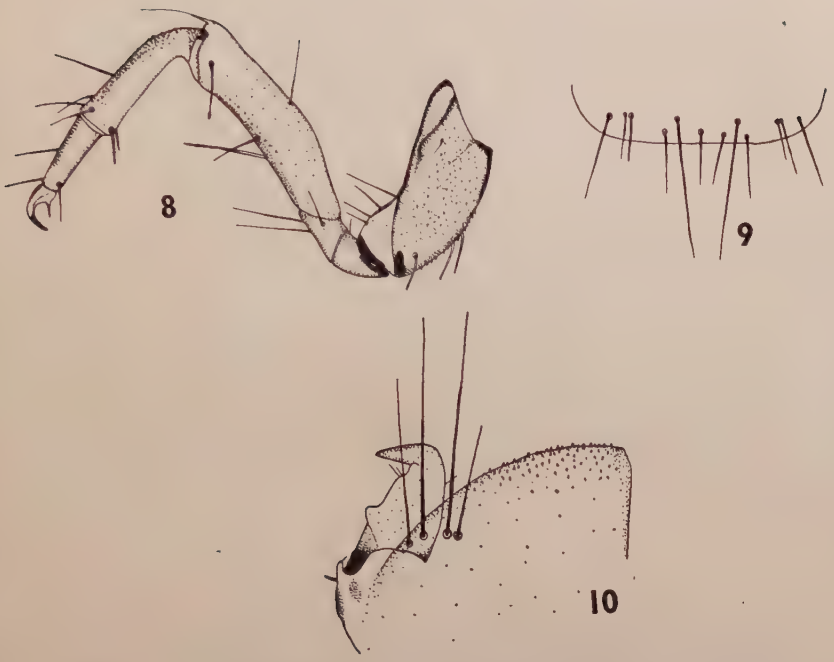
Goëra pilosa F. (Sericostomatidae).

Abundant larvae of *Goëra pilosa* F. were collected from a stream at Temple Balsall, Warwickshire, where they were crawling over the stones and small pieces of rock in the centre of the stream. The current flowed strongest at this point and they were in company with *Stenophyllax stellatus* and *Agapetes fuscipes*. Some of the larvae were reared to the adult stage and the determination of the species confirmed.

Larva eruciform, head orthocentrous. Sides and frontal region of genae partially covered by extensions of the pronotum. Metanotum only partially sclerotised. Length 13 mm., width 3 mm. *Case* (fig. 1) consists of central cylindrical part of sand grains or small rock fragments cemented together with small pebbles or larger rock fragments at the sides forming wing-like extensions. Cylindrical part slightly curved and flattened on the ventral surface. Anterior opening oblique. Length of case 15 mm., width 4·5 mm., width overall 10 mm. *Head* (fig. 2). Surface of head covered with minute pustules. Genae converging towards labrum. A ridge runs parallel with the genae on each side between the outer face of the genae and the clypeus. Antennae very small, of two parts, the proximal bulbous, the distal filiform and slightly curved. Chaetotaxy as in figure. *Gular sclerite* (fig. 6) triangular, with anterior transverse bar. *Labrum* (fig. 3). Anterior membranous part quite distinct and separated into three convex lobes, the lateral lobes very hairy. *Mandible* (fig. 4) triangular, base of outer edge furnished with two bristles, inner edge clothed with a brush of hairs, sclerotisation at apex bifid. *Maxillae* (fig. 5). Palp four-segmented, golden brown, short and wide with brush of outwardly directed hairs. (Ulmer gives maxillary palp 5-segmented.) Maxillary lobe short, bearing many hairs directed towards the labium, and three fairly large bulbosities. *Labium* (fig. 5) covered with small spinulose protuberances, labial palp two segmented, proximal segment large and membranous, sensory papilla on distal segment carrying a stout bristle. (Ulmer gives one segment, Lestage *in* Rousseau two segments.) Pair of partially sclerotised quadrangular plates on ventral surface of mentum with a heavily sclerotised black bar stretching from the anterior outer angle of each plate to the base of labium. *Thorax* (fig. 7). Prothorax sclerotised, almost capsular, with anteriorly projecting angles into which the head is recessed. Median longitudinal suture slightly bent where it traverses a small area of the tergum which is not so heavily sclerotised as the remainder. A partial lateral suture occurs contiguous with a horny longitudinal ridge apparently as though a separate sclerite at the posterior outer angle has become fused to form a single sclerite at each side. Mesothoracic notum consists of two pairs of sclerotised plates. The larger inner pair are roughly quadrangular, are divided by the median suture, and have the anterior margin beset with very short spines; there is a small dark mark near the inner anterior angle in each sclerite, and the posterior margin is darker in colour. Outer pair of sclerites roughly triangular but with a heavily-sclerotised black beak-like projection on the outer margin. A characteristic feature of the mesothorax is the large spinous scoop-like flap (fig. 7*a*) projecting from the coxal sclerite and fitting round the proximal part of the coxa. Metathorax partially sclerotised. Two pairs of sclerites on the tergum and relatively large coxal sclerites (fig. 7*b*). *Legs* (fig. 8) approximately equal. Tibia and tarsus short.



FIGS. 1–7.—1, Case (ventral view). 2, head. 3, labrum. 4, mandible. 5, maxilla and labium (ventral view). 6, gular sclerite. 7, thoracic sclerites.



FIGS. 8–10.—8, Prothoracic leg. 9, position of bristles on anal segment. 10, anal claw from above.

Tarsal claw strongly curved and arising from a swollen base which bears a short stout spine. *Abdomen* cylindrical, diminishing slightly in width towards the posterior end, creamy-white in colour. Lateral and dorsal protuberances present on first abdominal segment. Filiform gills present on abdominal segments 2 to 7, united at their bases into groups of three (sometimes two). These groups occur pre- and post-segmentally on the dorsal and ventral surfaces, and an additional single group occurs laterally on the ventral surface of segment 2. Lateral line present and commencing at the middle of the third segment and terminating at the end of the eighth. Series of sclerotised pustules dorsal to the lateral line also present, from two to six in each segment. Anal sclerite not heavily sclerotised but with series of bristles as shown in figs. 9 and 10. Anal claw without auxiliary claws, sharply bent. Four long bristles arise near the base of the sclerite supporting the claw, of which the middle pair are the longest.

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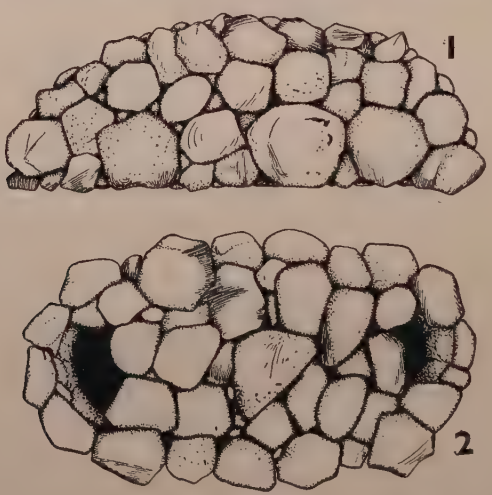
LARVAE OF THE BRITISH TRICHOPTERA. 16

By N. E. Hickin, Ph.D., F.R.E.S.

Agapetus fuscipes Curtis (Rhyacophilidae).

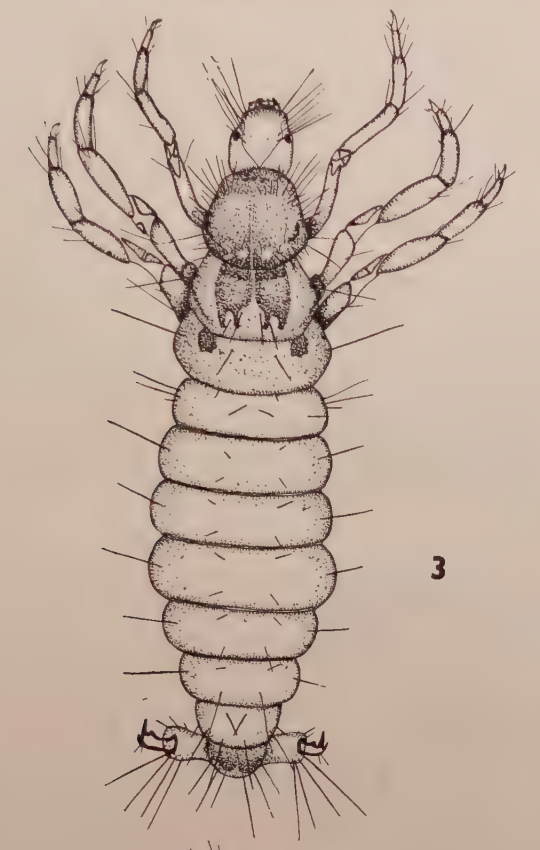
The specimens from which this description was made were collected from a small stream at Cranham, Gloucestershire, and compared with larvae collected from a stream at Sutton Park, Warwickshire. Both streams are shallow, swiftly flowing, and have a stony bottom. In both localities the larvae were present in considerable numbers, many thousands of the small cases coating the stones and rocks on the stream bed. Many adults were subsequently reared from larvae collected at each of the localities.

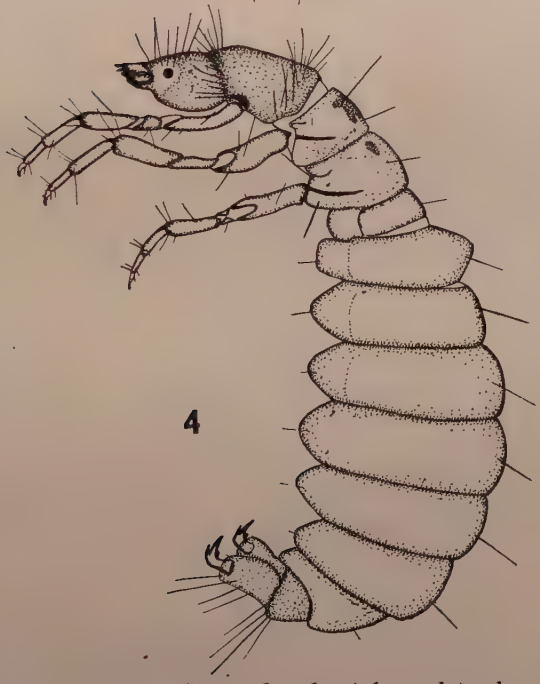
Case (figs. 1 and 2), of stone chips, small pebbles and sand grains with the dorsal surface hemispherical and the ventral surface flat. An opening occurs at anterior and posterior ends, and in the same plane as the ventral surface. Shortly before pupation the case is fastened



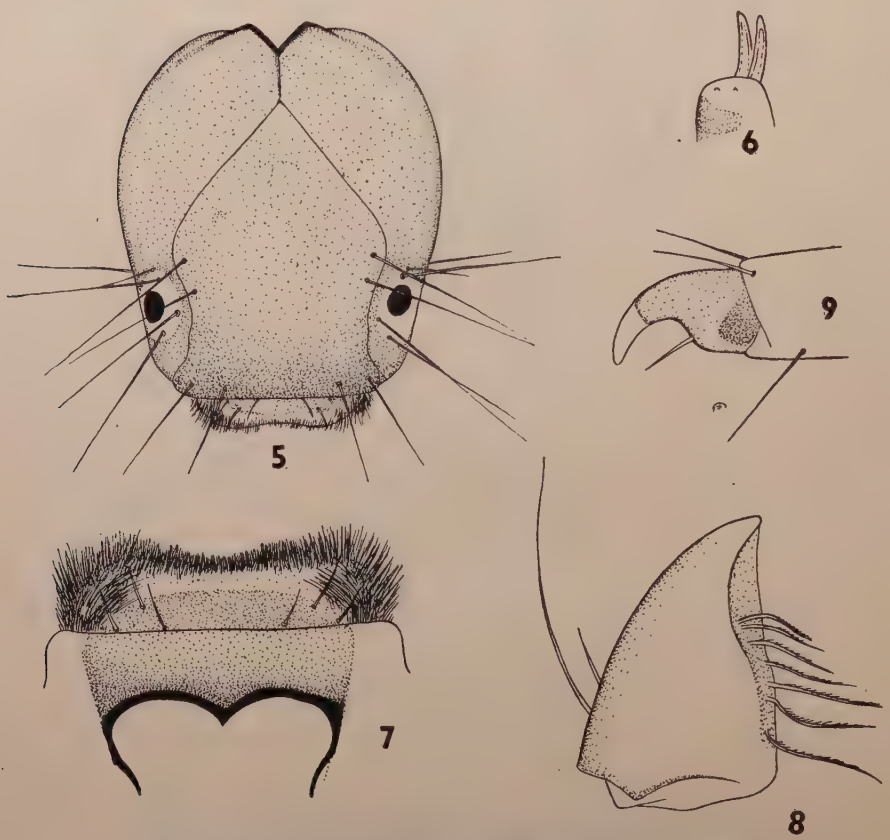
Figs. 1–2.—1, Larval case, lateral. 2, larval case, ventral.

to a stone or rock. Length 6–8 mm., width 4–5 mm. *Larva* (figs. 3 and 4), eruciform, length 6·0 mm., width 1·3 mm. Fusiform curved abdomen, gills absent. *Head* (fig. 5) orthocentrous, dark brown, oval, widest at aboral end. Eyes set fairly near to oral end and situated in pale areas surrounded by large bristles. Aboral end of head free from bristles. Clypeus wide with faint marks at aboral end, much darker colour at oral end. Antennae (fig. 6) small, consisting of basal lobe with two finger-like projections. *Mouth-parts*, labrum (fig. 7) heavily sclerotised except anterior margin which is very hairy. Base of labrum with black, bow-shaped sclerite. Mandibles (fig. 8) with inside edge produced to a slim blade at upper end. Approximately 7 long bristles, with secondary hairs, arise from the inside edge. Labium small, segments of maxillary palp indistinguishable, maxillary lobe hairy, labium hairy. *Thorax*, pronotum completely sclerotised, dark brown. Two transverse rows of bristles, a few light spots along posterior row. Median suture. Mesonotum partially sclerotised, two distinct dark brown sclerotised patches have two





FIGS. 3–4.—3, Larva, dorsal. 4, larva, lateral.



Figs. 5–9.—5, Head. 6, antenna. 7, labrum. 8, mandible. 9, tarsal claw of mesothoracic leg.

small projections extending from posterior edge. Metanotum with pair of small, distinct, sclerotised patches. *Legs*, approximately equal. Tarsal claws blunt with a basal spine and a dark mark at the point of insertion in the tarsal segment. *Abdomen*, curved ventrally, widest at about the fifth segment. Lateral line absent. Anal hooks with a single auxiliary hook, extended laterally by a basal lobe with a bulbous projection at the proximal end. Lobes and 9th segment darker in colour.

References.

Mosely, M. E., 1939, *The British Caddis Flies* : 248.
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Silfvenius, A. J., 1905–1906, *Acta Soc. Fauna Flora Fennica* **27** (6) : 157.
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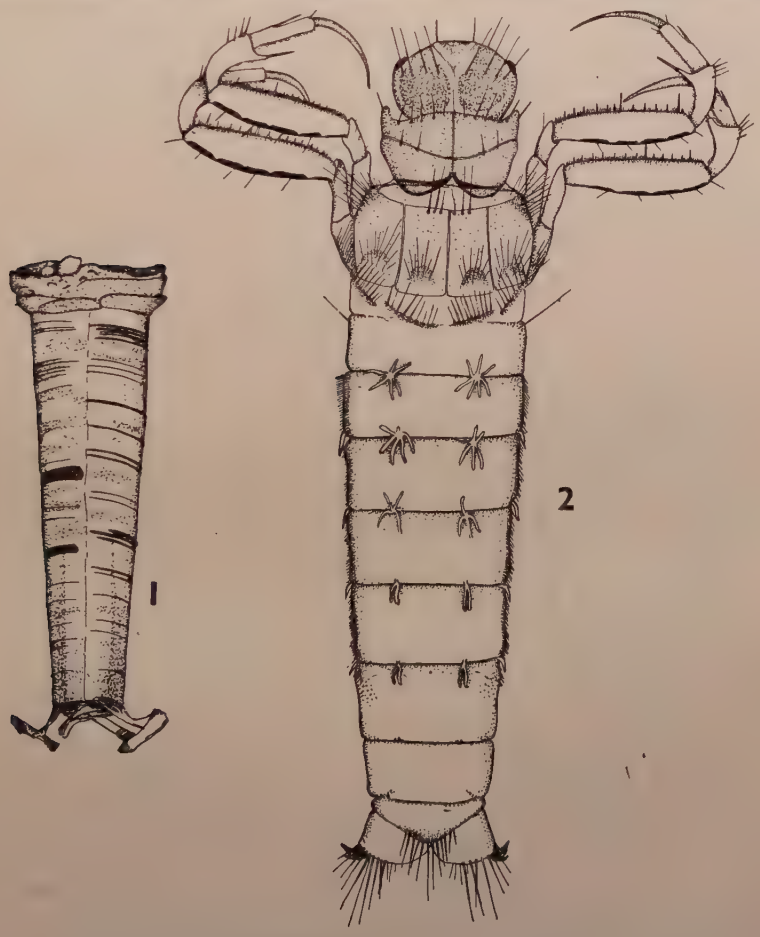
LARVAE OF THE BRITISH TRICHOPTERA. 17

By N. E. Hickin, Ph.D., F.R.E.S.

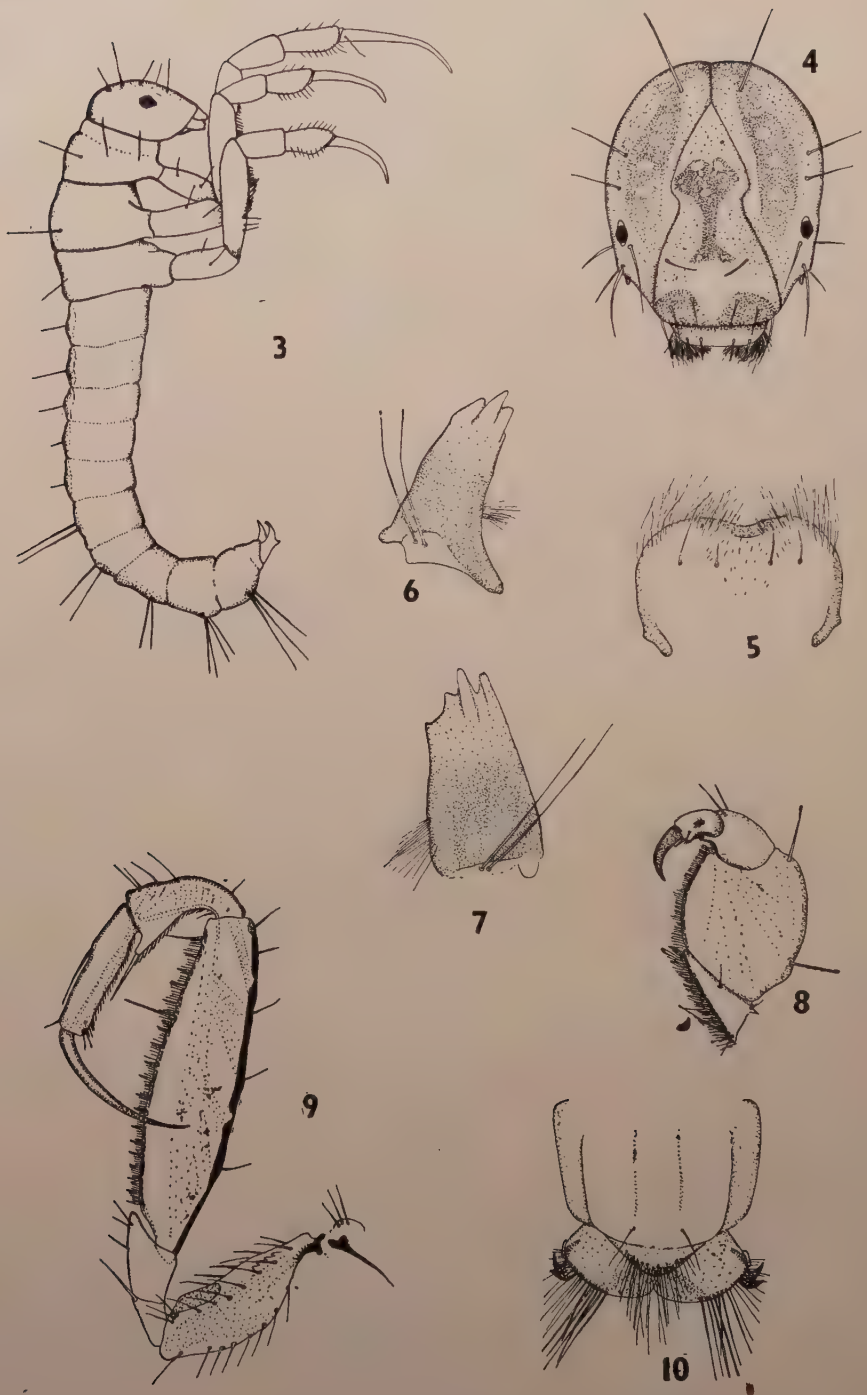
Brachycentrus subnubilus Curtis (Sericostomatidae).

This species occurs in rivers and streams. The description of the fully grown larvae is taken from specimens from the R. Kennet, Berks, given to me by Mr. M. E. Mosely, whilst the description of first instar larvae is taken from specimens hatched from an egg mass laid by a captured female. These unfortunately died within a day or two of emergence.

Case (fig. 1). The young larva constructs a case of vegetable debris, cut leaves (arranged transversely) and secretion, rectangular in cross-section, but older larvae construct the case from secretion only; it is circular in cross-section and the posterior end is attached



Figs. 1–2.—1, Larval case. 2, larva, full grown.



FIGS. 3–10.—3, Larva, 1st instar. 4, head. 5, labrum. 6, left mandible. 7, right mandible. 8, prothoracic leg. 9, mesothoracic leg. 10, anal segment.

to the roots of water weeds or stones and rocks, often very many together. The tail end of the case is partly sealed by secretion, leaving a circular orifice. Transverse dark markings are very often a feature of the case. Length 12 mm., width 2–3 mm. *Larva* (figs. 2–3) eruciform, head orthocentrous. The legs are bunched up beneath the thorax and head. *Head* (fig. 4) golden brown with a darker area at the anterior margin of the clypeus (which is provided with a row of four bristles). Back of the head darker also. Dark bands run longitudinally over the genae just skirting the clypeus on each side. Four light-coloured spots are contained in each band anterior to a prominent pair of bristles. Within the aboral area of the clypeus is a dark patch containing three mushroom-shaped lighter markings with their stalks together. From the dark patch, a dark mark runs to the aboral end of the clypeus where it runs into a light-coloured heart-shaped patch with its apex pointing orally. The light-coloured area is probably due to reflection rather than to lack of pigment. Length 10–12 mm., width 2·5 mm. *Mouthparts*, labrum (fig. 5) with dense brush of hairs projecting from each side of a small heavily sclerotised concavity at the centre of the anterior margin. Mandibles (figs. 6–7) asymmetrical, two large bristles situated at the base on a plate-like extension which is not very heavily sclerotised. A brush of hairs is situated on the inside edge. Each mandible has four teeth but the teeth of the left mandible are more closely packed together than those of the right. Colour black, except anterior quarter which is deep chestnut. Maxillae with palp 5-segmented and with brush of hairs at base. Maxillary lobe hairy. *Thorax*, prothorax sclerotised, approximately as wide as the head. Anterior margin convex provided with bristles. A transverse concave suture present also provided with a few bristles. Median longitudinal suture present. Posterior margin of prothorax heavily sclerotised, especially laterally, black in colour. Prosternal " horn " absent. Mesothorax only lightly sclerotised, a little wider than prothorax; three longitudinal sutures, one median, two lateral; more heavily sclerotised at the lateral anterior vertices of the notum and at four transverse patches near the posterior margin each situated in a separate sclerite (as divided by the sutures). Each sclerotised area is provided with a few strong bristles. Metanotum unsclerotised except for four narrow patches provided with bristles and arranged in the form of a crescent, concave anteriorly. *Legs* (figs. 8–9), prothoracic legs short and very broad, the tibia being especially broad. Ventral margin of tarsus, tibia, and trochanter fringed with hair. Meso- and metathoracic legs similar in size and characteristics, the tibia deeply marked along the dorsal surface with black, whilst the ventral margin is fringed with spines of two sizes, equally spaced and between which are small hairs. Tarsal claw very long and on the dorsal surface of the distal tarsal segment is a stout bristle which usually lies along the surface of the segment. A ventral spine on the proximal segment of the tarsus is situated on a considerable prolongation. *Abdomen*, greyish-white. No protuberances on first abdominal segment. Gills present on the 2nd to 7th segments. A pair of tufted gills lie on the dorsal surface of the segments near the posterior margin and become progressively reduced. The gills on the 7th abdominal segment may be very much reduced.

A " lateral line " of fine hairs in the pleural region occurs from segments 3 to 7.

The young larva on being hatched from an egg mass has the legs all similar in length and shape, well developed and large. The thoracic nota are not differentiated into sclerites. The tarsal claws are extremely long. Each segment of the abdomen bears two or more large spines.

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Mosely, M. E., 1939, *The British Caddis Flies* : 123.
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Ulmer, G., 1903, *Metamorph. Trichopt.* : 87, fig. 6, 17, 28, 57.
——, 1903, *Allgem. Z. Ent.* **8** : 346.
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1943.

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" November 3
" December 1

1944

" January 19 (ANNUAL MEETING)
" February 2

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